SYMONS'S
MONTHLY
METEOROLOGICAL MAGAZINE.

CIX.] FEBRUARY, 1875. [PRICE FOURPENCE, or 5s. per ann. post free

THE RAINFALL AND THE SUGAR CROP OF BARBADOS.*

WE ought perhaps to apologize for the long delay which has occurred before noticing this excellent monograph, but we have been waiting in the hope that even after issuing it, Governor Rawson might have seen his way to supplying that which to those unacquainted with the Island is almost indispensable, namely, a map of the stations. We can quite understand that such a production might have been beyond the resources of Barbados printers, (although they seem to do their work well,) but Governor Rawson has surely plenty of friends in this country who would gladly have seen such a map through the press for him, if he had supplied the original MS. We regret its absence all the more, because, as we hope to show, the report is in other respects exceptionally good.

Before proceeding to examine the results, and premising that both in its size (166 square miles against 136,) and in the elevation of its highest point (1104 ft., against 835 ft.) Barbados closely resembles the Isle of Wight; we leave the Governor to describe its position and physical characteristics:—

"Barbados is an oblong Island, of greater length (from North to South), than breadth, say—21 by 14 miles. Its area is 166 square miles, or 106,470 acres. It is situated in N. latitude, 13 deg. 4 min., and W. longitude, 59 deg. 37 min., about 80 miles outside, and Eastward, of the belt of Islands forming the Windward, or more Southern, portion of the group which encircles the Caribbean sea on its Eastern side. The greater part, about seven-eighths, consists of a succession of limestone and coral terraces, the sides of which often bear evidence of having once been shore cliffs, and resting upon a clay foundation. These do not rise in the highest point above 1,147 feet.† This part is intersected by numerous ravines and gullies. The primitive forests, of which there are both physical and historical evidence, have disappeared. Scarcely a vestige of them remains; and outside of Bridgetown, with the exception of a few acres of wood in two or three parts of the island, several small copses of young mahogany trees, the remnants

* Report upon the Rainfall of Barbados, and upon its influence upon the Sugar Crops, 1847–71, with two supplements 1873–4, by Governor Rawson, C.B. Presented to, and ordered to be printed by, the House of Assembly of Barbados, 1874. Folio, 167 pages.

† Height of Mount Hillaby by old survey, reduced to 1,104 ft. by the recent trigonometrical survey of Staff Commander Parsons, R.N.

of alleys of cabbage palms, and small clumps of ornamental trees surrounding most of the country residences, the island is denuded of trees. It presents one vast cultivated field, undivided except by roads, planted with sugar canes, or grain and root crops, with rare and very small patches of pasture land, covered with sour grass, on most of which the soil is too scanty for cultivation. Of lakes there are none; streamlets, scarcely any; the ponds, once numerous, are rapidly disappearing, being exhausted and taken into cultivation.

"The smaller portion, which is on the windward side, differs in the absence of the horizontal limestone and coral strata, in its irregular and broken structure, resembling 'a miniature alpine country.' Its aspect, surrounded by the limestone and coral rocks of the highest section of the island, which assume in many parts the abruptness and height of cliffs, is as if the calcareous superstructure had been torn off, and cast out of sight, by some convulsion of nature, possibly volcanic, as if the foundation of the whole island, had in this part of it been left bare, and had assumed its present superficial appearance from the action of the weather through successive centuries. Coralline boulders remain on the beach and elsewhere, but whether they formed part of the original covering of this district, or have rolled down from the cliffs still overhanging it, may be a question.

"The island is exposed to the trade winds, varying but slightly from N.E., during three-fourths of the year. The rain comes chiefly from the same quarter, but at certain seasons occasional shifts of wind to the S.W. and N.W. bring with them heavy showers, which generally do not reach the windward side. The island lies nearly in the latitude in which the circular storms of the northern hemisphere are supposed to be generated. The majority of them assume their destructive force to the northward of the island, or pass by it to the N.E. Few comparatively have swept the island in their westerly course, or recurved upon it from the N.E. Fewer still have passed by it to the Southward.

"There is little in the surface of the island to attract, or to promote the generation of, rain. The faces of terraced cliffs of coral rock are likely to increase the rainfall in their immediate neighbourhood. But for the most part the rainfall depends, apart from elevation, upon the exposure of the land to those winds which at different seasons of the year strike the island laden with moisture, and discharge their burthen on the lands which they first meet. It happens very rarely that rain falls over the whole island at the same time, or in equal proportions."

In this little Island 178 stations were at work when this report was written, a number which has since been raised to 225, or rather more than one station to each square mile. This is a very much closer network of stations than is necessary in the British Isles, where with 120,000 square miles, we have about 1,700 stations, or about one station to each 70 square miles. The stations in Barbados are therefore more than seventy times as numerous as they are on the average in the British Isles. We do not quite understand the necessity for such extreme proximity, but the Governor has had longer experience in the Island than we have, and we therefore raise no objection on this score.

The report contains in various appendices, abstracts of nearly all the rainfall observations made in the Island; and in this respect it is an invaluable storehouse of facts. For three stations the daily observations are printed *in extenso*, from 1847 to 1872, and another appendix gives all the yearly totals observed between 1843 and 1871 inclusive, at 57 stations. This is an extremely important table. On scientific grounds, however, we must protest against the mode of averaging which has been adopted, viz., the quotient of the summation of each series of totals divided by the number of years—the averages

are therefore averages of periods of unequal length, varying from 4 years to 25 years, and as some include wet periods, and some do not, the resultant averages are not properly comparable. This error is so frequent, nay so rarely avoided, in similar tables, that it may be well to point out its serious nature by a fully worked out example, taken from three consecutive columns of the table under notice.

Years.	St. James, Leeward Lowland.			Differences from Sion Hill.	
	Sion Hill.	Westmoreland.	Holders.	Westmoreland.	Holders.
1857 ...	98·83				
8 ...	66·54				
9 ...	71·33				
1860 ...	79·81				
1 ...	84·40				
2 ...	96·42				
3 ...	63·81				
4 ...	71·76				
5 ...	79·79	82·17	...	+2·38	
6 ...	63·34	67·95	...	+4·61	
7 ...	79·31	84·80	...	+5·49	
8 ...	55·32	55·84	37·95	+ ·52	—17·37
9 ...	60·73	58·89	39·78	—1·84	—20·95
1870 ...	75·06	66·38	55·39	—8·68	—19·67
1 ...	48·53	46·38	39·16	—2·15	— 9·37
Average of whole periods	73·00	65·60	43·06		
Average 1865-71	66·01	66·06	...	+ ·05	
,, 1868-71	59·91	56·87	43·07	—3·04	—16·84

The portion of the above table within the dotted line is reprinted *literatim* from the report; if, however the yearly amounts, are correctly printed, the averages of the third and fourth columns should be 66·06 and 43·07 respectively. These, however, are relatively small differences, the salient feature is that the averages at the three stations are given as (to take the nearest inch), 73, 66 and 43. That is, that Sion Hill exceeds Holders by thirty inches, and Westmoreland exceeds it by twenty-three. If, however, we look at column five we shall find that Westmoreland and Sion Hill agree on an average within 0·05 in., and finally we find that during the five years in which observations were made simultaneously at all three stations, the first two exceed the last by seventeen and fourteen inches respectively, instead of by thirty and twenty-three as shown in the table.

As the errors due to this principle are equally likely to be *nil*, or + or −, it is probable that, were all the averages recomputed on the latest and best mode, they would agree in their general character with the present values, though individual ones might be raised or lowered by five or ten inches. Taking, however, the amounts as they are (and

we know of no equal area on the globe for which there are such full details,) it appears that the lower terraces all round the Island, receive about 52 inches per annum, rather less in the south-west (perhaps 47) and more (about 55) in the N.W. On the highlands in the interior the amount reaches 70 inches. This might have been anticipated from the elevation, for take it at 1000 feet and take the increase due to elevation at the ordinary value of 4 per cent., then low level average 52·00

Add 4 per cent. for each 100 ft., 1000 ft.=40 per cent. of 52·00=	20·80
Computed fall for 1000 ft. =	72·80

With respect to the seasonal distribution of rain, ample details are also given. In the following abstract we have converted the average results given in the report, into per-centages of the yearly total, which is by far the most easily intelligible way of considering seasonal distribution.

Amounts.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Average												
Highlands...	3·80	3·00	1·73	2·33	3·96	6·07	6·13	7·76	6·61	9·17	7·42	5·07
Lowlands ...	2·97	2·34	1·32	1·81	3·23	5·09	5·51	7·06	6·05	8·49	6·85	4·24
Per Centages.												
Average												
Highlands ...	6	5	3	4	6	9	10	12	10	15	12	8
Lowlands ...	6	4	2	3	6	9	10	13	11	15	13	8

From this it appears that the mean monthly rainfall steadily rises (September excepted,) from a minimun in March to a maximum in October, and then falls, more rapidly, to the above-mentioned March minimum.

We must now proceed from the Meteorological to the practical part of this able report, for Governor Rawson has proved that the sugar crop is calculable from the rainfall. As it is impossible in the limits of this article to discuss at length the exhaustive mode in which Governor Rawson has worked out this subject, we must quote such paragraphs as will give a general idea of the mode of investigation and of its results.

INFLUENCE OF RAINFALL ON CROPS.

"The next subject for consideration is the practical application of the information above detailed in examining its influence upon the staple crop—the sugar crop—of the island. The means of gauging this are accessible. Almost the whole of the sugar manufactured, probably within two per cent. of a good crop, or five per cent. of a bad one, is exported. It is generally shipped within the year in which it is manufactured. If otherwise, the Customs have the means of distinguishing the small remnant, and of including it in the crop to which it belongs. These records have been kept systematically for many years, since 1806, exactly two-thirds of a century. A return of the quantity in each year, 1806—1872, is contained in Appendix No. 28. The rainfall returns do not extend beyond 1847. But fortunately for the object of this inquiry, the absence of earlier Returns is of less consequence, as during the first half of the century various circumstances besides the Rainfall affected the crop of the season, such as the extension of cultivation, the abandonment of root-crops for the food of the slaves and

apprentices, which were generally grown up to 1838, improved methods of cultivation or processes of manufacture, and the influence of a fluctuating legislation affecting the sugar market, and encouraging or discouraging the employment of capital on the production and manufacture of the article. During the years immediately preceding and following Emancipation the crops were more or less affected by the irregularity of labour."

"The actual excess or deficiency, in inches, of the Rainfall in the years preceding the several years, ranged according to their crop, was as follows :—

Years.	Crops of year.		Rainfall of preceding year compared with average.	
	Above average.	Below average.	Inches above.	Inches below.
1868	29 per cent.	...	12·19	...
66	27 ,,	...	10·90	...
52	25 ,,	...	1·66	...
71.....	20 ,,	...	2·43	...
54.....	17 ,,	...	11·10	...
67.....	14 ,,	...	1·94	...
58.....	13 ,,	...	3·16	...
56.....	11 ,,	...	19·57	...
61.....	10 ,,	...	·17	...
62.....	2 ,,	...	1·66	...
65.....	2 ,,	...	1·45	...
55.....	1 ,,	...	...	6·86
51.....	average.		10·14	...
53.....			1·03	...
60.....	...	5 per cent.	...	3·52
63.....	...	6 ,,	1·53	...
50.....	...	9 ,,	...	4·97
59.....	..	12 ,,	...	12·52
70.....	...	13 ,,	...	9·22
57	...	14 ,,	...	9·25
49.....	...	15 ,,	6·03	...
64.....	...	17 ,,	...	15·36
48.. ...	...	27 ,,	...	9·64
69.....	...	28 ,,	...	13·14

"It only remains to show how the crop of any year may be measured by the Rainfall of the preceding year, with such an approach to accuracy in all but very exceptional years as to give a practical utility to the formula. The factors may require to be changed from time to time, as circumstances arise to affect either the area of land under canes, or the forms of cultivation or manufacture. But changes in these are not likely to be frequent or sudden in Barbados, and when they commence, their influence upon the crop will not be very rapid."

"The details of this calculation, and the process by which the amount of error was ascertained, are furnished in the following Table :—

Years.	Rainfall in inches.	Actual crop of following year.	Crop calculated at 800 Hhds. to the inch.	Difference between calculated and actual crop.	Per-centage of Difference.		Crop calculated at 800 Hhds. to the inch, with 7½ per cent. added or subtracted.	Difference between calculated and actual crop.	
		Hhds.	Hhds.	Hhds.	+	−	Hhds.	Hhds.	per cent.
1856...	48·49	38,798	38,792	— 6	Equal.		41,701	+2,903	+ 7·4
57...	60·90	50,788	54,720	— 2,068	...	4·0	50,616	— 172	— 0·3
58...	45·22	39,666	36,176	— 3,490	...	8·8	37,889	—1,777	— 4·4
59...	54·22	42,684	43,376	+ 692	1·4	..	46,628	+3,944	+ 9·2
60...	57·91	49,745	46,328	— 3,417	..	6·8	49,808	+ 63	+ 0·1
61...	73·82	46,120	59,056	+12,936	28·0	...	..	...	...
62...	59·27	42,281	47,416	+ 5,135	12·2	...	43,861	+1,580	+ 3·6
63...	42·38	36,199	33,904	— 2,295	...	6·3	36,456	+ 257	+ 0·7
64...	59·19	46,068	47,352	+ 1,284	2·7	...	43,801	—2,267	— 4·9
65...	68·64	57,188	54,912	— 2,276	...	3·9	59,030	+1,842	+ 3·2
66...	59·68	51,304	47,744	— 3,560	..	6·9	51,324	+ 20	Equal.
67...	69·93	58,250	55,944	— 2,306	...	3·9	51,748	—6,502	—11·2
68...	44·60	32,150	35,680	+ 3,530	11·0	...	38,356	+6,206	+19·3
69 .	48·52	39,270	38,816	— 454	...	1·1	41,726	+2,456	+ 6·2
Averge	56·63	45,036	45,301	+ 265	...		45,611	...	...

"The almost identity of the average actual crop, for the whole period, with the average calculated at 800 hhds., is most remarkable. But individual years do not tally so closely; yet an examination of the columns showing the per centage differences between the calculated and the actual crops, affords the remarkable result that within the limits of 800 hhds. to the inch of rain and 860 hhds. (7½ per cent. on 800) there are only three out of fourteen years in which the difference amounts to 5 per cent., a difference which, in calculating a crop before a hogshead of sugar is made, is almost inconceivably small.

In the earlier portion of the above table we have corrected the somewhat numerous errors of calculation and printing, but as in one or two cases in column 8 we are not sure of the author's intention we have reprinted it and the subsequent columns *literatim*. We are, moreover, inclined to think that in the last paragraph, the clause "within the limits of 800 hhds. to the inch of rain and 860 hhds." should be 740 hhds. and 860 hhds., since from col. 8 above-mentioned the 7½ per cent. seems to be sometimes added and sometimes subtracted.

REVIEWS.

Annalen des Physikalischen Centralobservatoriums, herausgegeben von H. WILD, Jahrgang, 1872. K. Akademie der Wissenschaften, St. Petersburgh, 1874. 4to., 720 pages.

DR. WILD'S annual volume improves in quality and increases in size. In fact, its size is proportional to the vast Russian Empire, respecting the meteorological phenomena of which it gives ample and very well arranged information. Among the improvements in quality, we may specially quote the small abstract tables for the year, now given for each station. We reprint (translating and converting) that for Archangel, as a specimen of which some of our readers may be glad, and we preface it with information respecting the instruments which the Russians (in this respect so much wiser than other nations) always give.

ARCHANGEL, 1872.

Lat. 64° 33′, long. E. of Greenwich 40° 32′ (2^h 42^m 8^s).
Height of the barometers above the sea $7^m{\cdot}3$ (24·1 Russian feet).
[N.B.—The Russian and English foot is identical in length.—Ed.]
Height of the thermometers above the ground $3^m{\cdot}0$ (10 feet).
Height of the rain gauges above the ground $4^m{\cdot}9$ (16 feet).

The barometer is graduated in Russian half lines, and its indications have been converted into millimetres. The correction of the barometer is not known, but it is probably between —5 mm. and —6 mm. [between —0·197 in. and —0·236 in.]

The corrections of the centigrade thermometers No. 59^1 and 59^2 have been applied. On days when the temperature was below —25° [—13·0 F.] the humidity was computed from the hair hygrometer.

Observers—Ogorodnikof and Rastof.

Months.	Monthly and Yearly Means, from Observations at 7 a.m., 1 p.m., and 9 p.m.						Number of Days with								
	Temperature.	Elastic Force.	Relative Humidity.	Barometer	Cloud.	Depth of Rain.	Hail, Graupel Rain or Snow.	Snow and Graupel	Hail.	Fog.	Thunder and Lightning.	Strong Wind.	Sky. Clear.	Sky. Overcast.	Temperature. Min. below 32°	Temperature. Max. below 32°
	deg.	in.	0—100	in.	0—10	in.										
Jan. ...	11·6	·073	92·0	30·061	8·9	2·03	17	17	...	...	...	...	...	21	31	31
Feb. ...	10·1	·070	92·0	30·186	7·3	·13	9	9	..	2	...	...	2	13	29	29
Mar. ...	12·2	·084	90·5	29·904	5·8	·82	11	11	...	..	...	6	5	7	30	26
April ...	31·8	·156	84·5	30·004	7·2	1·30	14	5	...	1	...	1	2	11	17	7
May ...	42·6	·200	72·7	29·979	6·0	1·42	12	2	...	1	1	3	2	4	5	1
June ...	54·4	·256	60·3	30·093	3·5	·28	4	1	...	...	...	...	12	2	...	...
July ...	58·9	·338	66·8	29·890	5·5	4·06	8	..	.	1	4	1	3	4	...	..
Aug. ...	58·4	·387	77·3	30·009	5·1	1·19	8	...	...	3	2	1	4	2	...	...
Sept. ...	43·6	·241	82·5	29·740	7·0	2·99	10	5	...	...	...	...	3	11	4	...
Oct. ...	38·3	·217	89·4	30·013	7·8	1·50	14	3	...	2	...	1	...	5	8	4
Nov. ...	18·3	·103	84·0	29·918	8·4	2·52	15	13	...	5	...	1	...	12	26	24
Dec. ...	8·7	·082	88·8	29·868	8·3	·79	6	6	...	2	...	5	1	10	26	23
Year ...	32·5	·183	81·7	29·972	6·7	19·03	128	72	...	17	7	19	34	102	176	145
Max. ...	80·8	·693	98·0	30·690	10	...										
Min. ...	—37·5	·004	28·0	28·678	0											

On the Thermal Influence of Forests. By ROBERT LOUIS STEVENSON. [Proc. Roy. Soc., Edinburgh.] 8vo.

THE questions raised by Bequerel in his *Climats*, and by the Hon. G. P. Marsh, in *Man and Nature*, are gradually receiving that which they most require, namely, rigorous examination. Dr. Brandis and his fellow-labourers in India, Ebermayer in Bavaria, and many others, are steadily collecting materials far superior to those accessible even to the laborious research of Mr. Marsh, and it is well that it should be so, for the influence of forests and even of cultivation on the climate of localities is a matter of great importance, as we believe our neighbours on the other side of the Atlantic are discovering.

The present paper does not contain any new instrumental observations, but, it is a very calm and clear *résumé* of facts from various quarters bearing on the thermal influence of forests.

Le Variazioni del Vento. Lettura del Prof. DOMENICO RAGONA, Direttore del R. Osservatorio di Modena. Milan: Fratelli Treves, 1874. 8vo.

A HANDY little popular abstract of the directional variations recorded by the Anemometer at Modena Observatory, during the six years, 1867-72.

Prof. Ragona, in accordance with the decision of the Vienna Congress, adopts the English initials for the direction of the winds, but he gives for the convenience of his readers the Italian equivalents, and we for the benefit of our readers, may as well give them also.

N.	Tramontana.	S.	Mezzogiorno.
N.E.	Greco.	S.W.	Libeccio.
E.	Levante.	W.	Ponente.
S.E.	Scirocco.	N.W.	Maestro.

The mode of discussion adopted is, we believe, new, and brings out clearly the relative frequency of direct and retrograde motion, the amount of directional variation at different hours of the day, and with the prevailing wind in various quarters, and the pamphlet is therefore worthy of the attention of all who are charged with the publication of anemometric records.

I Venti Impetuosi. Lettura del Prof. DOMENICO RAGONA, Direttore del R. osservatorio di Modena. Milan: Fratelli Treves, 1874. 8vo.

ALTHOUGH less novel, this is perhaps a more useful paper than the one which we have just noticed. Prof. Ragona starts well by describing in a couple of paragraphs, why strong winds blow. As he puts the matter very clearly, we translate them.

Everything which tends to modify the density of the air, alters the equilibrium of the atmospheric ocean. If at two spots on the earth's surface the density of the air be very different, an atmospheric current will evidently be established between these two regions, in order to restore the equilibrium and, to compensate the defect in one place by the excess from the other. Thus clearly, by the relation

of cause and effect, the greater the departure from equilibrium, the more rapid the resultant current to restore it. The causes which modify the density of the air are many and various. Heat and moisture are the great causes of disturbances of atmospheric equilibrium. The barometer, in short, gives a very good representation of the movements of the air, for if the pressure be unequal at two places a current of air is established between them, and a wind blows from that of greater to that of lesser pressure, and the greater the difference between the barometric readings at the two places, the more rapid will be the current between them.

We cannot follow in equal detail the remaining sixty pages of this pamphlet, but must content ourselves with picking out a few of the more salient points. The Modena anemometer is a velocity instrument recording in kilometres per hour, and it appears that 30 kilos-hour (or 19 English miles-hour *i.e.*, miles per hour), may be regarded as constituting a strong wind at Modena, for winds of that velocity, or above it, only occur about 25 times a year, as is shown by the following abstract:—

Month.	Mean annual frequency of Winds of 19 miles an hour	Mean velocity of High Winds.	Strongest Wind.		Date.		
			Direction.	Velocity.			
		miles hour		miles hour	Y.	D.	H.
January	1·1	22	...	26	1867	31	8P.M.
February	0·9	23	N.	31	72	22	2P.M.
March	4·3	22	S.E.	32	71	29	8A.M.
April	3·9	22	...	32	67	9	11A.M.
May	2·6	21	...	28	67	23	2P.M.
June	1·9	22	S.	33	69	15	10A.M.
July	1·0	20	S.W.	22	71	25	0
August	·9	20	W.	22	72	4	3A.M.
September	1·9	21	S.W.	28	67	20	7P.M.
October	3·1	22	N.E.	31	69	20	11P.M.
November	2·4	23	N.E.	37	71	18	2A.M.
December	1·4	23	S.W.	32	1872	3	6A.M.

We must close with the translation of one or two paragraphs which contain weighty truths too often overlooked.

The values above quoted can only give a feeble idea of the real vel ocity of a strong wind, because the stratum of air level with the anemometer, though 150 ft. above the ground, is greatly retarded by friction against the earth's surface.

And again:—

The values quoted in the above abstracts are the direct result of the observations, but do they correctly record the velocity in kilometres? It would be rash to reply positively in the affirmative. *Each Anemometer has, so to say, its own personal equation.*

We abruptly terminate our quotation with this remark, which is as important as it is true—because there is no lesson which the directors of observatories, both public and private, so much require to be taught, as that at the present time there are scarcely two anemometers in Europe, which are comparable one with another. Prof. Ragona is perfectly right in stating that "Each anemometer has its own personal equation."

Third Report of the Meteorological Office of the Dominion of Canada, for fiscal year ended 30th June, 1873. By G. T. KINGSTON, M.A., Superintendent, 1874. Large 8vo.

THREE years is not nearly a sufficiently long period to determine accurately any meteorological element. Considering, however, the urgent need of approximately correct information respecting the various climates which prevail in different parts of the Dominion, all must agree that Prof. Kingston has done wisely in preparing and publishing four tables of which the headlines are as follows :—

I. Monthly, Quarterly and Annual Means of Temperature
II.* Averages of the Highest Temperature in each month and year
III.* Averages of the Lowest Temperature in each month and year
IV. Monthly, Quarterly and Annual Rainfall, and total Precipitation

} at various places in the Dominion of Canada derived from three or more years.

Prof. Kingston gives the figures, but he gives no comments. We cannot spare space for all the tables, so we jot down a few remarks.

First as to the Monthly Mean Temperature. That of the three winter months, December—February, is remarkably uniform at all stations; January is in almost all cases the coldest month, but only by about 1°. Similarly, the three summer months are very nearly equally warm, July perhaps exceeding June and August by 2° The coldest winter station (mean temp. for January, 10°·2,) is Fitzroy Harbour, Ontario; and the warmest winter station (mean temp. for January, 24°·3,) is Windsor, Ontario. The highest mean monthly summer temperature (July, 72°·8,) occurs also at Windsor, Ontario; and by far the lowest (July, 59°·7,) at St.John's, New Brunswick. The greatest difference between summer and winter is 61°·0 at Fitzroy Harbour, Ontario, and the least at Halifax, 40°·6. The highest mean annual temperature is 47°·3 at Windsor, Ontario, and the lowest is 39°·5 at Bass River, New Brunswick.

The extremes of temperature will not require so much notice. The average absolute max. temp. of each summer, ranges from 79° at St. John's New Brunswick, to 99° at Hamilton, Ontario; over the whole Dominion the shade temperature usually passes 90° each summer, and there are three records exceeding 100°.

There is no Canadian station at which the temperature does not usually fall below zero every winter; the least severity is in Nova Scotia; but even at its warmest station, Glace Bay, the temperature usually falls on one night to —7°·5, and has fallen to —13°·0. This, however, is quite mild compared with Fitzroy Harbour, Ontario, where it usually falls to —38°·0, and has fallen to —41°·0. But even this was, however, once exceeded at Pembroke, Ontario, where the temperature fell to —45°·0.

The mean rainfall varies less than we should have expected, con-

* These tables also give the absolute highest and lowest observed temperatures.

sidering the vast area of the Dominion. Averages are given for 28 stations, viz.—

19 in Ontario,	of which the highest is	40·64 at Simcoe,	lowest	25·20 at Glencoe.
3 in Quebec,	,,	37·54 at Montreal,	,,	31·84 at Quebec.
2 in New Brunswick,	,,	43·12 at St. John's	,,	43·91 at BassRiver
4 in Nova Scotia,	,,	66·00 at Glace Bay	,,	49·23 at Picton.

The mean for Ontario and for Quebec seems to be about 33 inches, for New Brunswick 42 inches, and for Nova Scotia 57 inches.

Although of course we have as usual included *all* precipitation under the general term rain, a moment's reflection will remind everyone that with winter temperatures far below zero, rain is an impossibility. The snow fall in Canada is great, and appears to amount to about 8 feet each year.

In leaving this very useful report, we must not fail to express our earnest hope that Prof. Kingston may in his next contrive to give the tables grouped for the civil year, not as he has hitherto (for what may be considered political reasons only,) done from September of one year, to August of the next. Thereby he renders his mean values absolutely incomparable with those of other systems. We hope that he will try to alter this; and that he will not be thwarted in the attempt.

SUPPLEMENTARY TABLE OF MONTHLY RAINFALL, JANUARY, 1875.

Div.	County.	Station.	Total Fall.
			in.
II.	Kent	Margate (Acol)	2·57
,,	Sussex	Hailsham	2·11
,,	Hampshire	Strathfield Turgiss	3·63
,,	Oxford	Oxford (Magdalen College)	3·62
,,	Essex	Harlow (Sheering Rectory)	2·31
,,	Cambridge	Cambridge (Merton Villa)	2·24
IV.	Norfolk	Swaffham	2·40
V.	Devon	Teignmouth (Brookbank)	5·30
,,	,,	Torrington (Langtree)	8·34
,,	Somerset	Taunton	3·57
VII.	Leicester	Melton Mowbray (Coston Rectory).	2·19
,,	Lincoln	Horncastle (Bucknall)	1·78
VIII.	Lancaster	Liverpool (Walton-on-the-Hill)	3·88
IX.	York	Wakefield (Stanley Vicarage)	3·06
X.	Durham	Gainford	2·38
,,	Westmoreland	Shap	10·90
XVII.	Banff	Keith	2·09
XVIII.	West Ross	Strathconan	7·19
XX.	Cork	Fermoy (Glenville)	9·09
XXI.	Dublin	Kilsallaghan	2·69
,,	Westmeath	Athlone (Twyford)	5·38
XXII.	Galway	Ballinasloe	5·71

RAIN GAUGES.

To the Editor of the Meteorological Magazine.

SIR,—I would be greatly obliged if you or any of your readers would kindly tell me how many ounces of water fall to the inch of rain in a 6-in., 9-in., and 12-in. diameter rain gauge respectively.

I want to graduate a measuring-tube for a rain gauge I am setting up, and, if I am informed on this point, can secure further accuracy by comparing my observations for some time with those from a standard gauge.—I am yours, faithfully,

E. MACDOWEL COSGRAVE.

Reading Rooms, Trinity College, Dublin.

[There is evidently some mysterious charm about making rain gauges, in which we do not share. Over and over again in these pages and in those of *British Rainfall* we have protested against observers making their own rain gauges, and yet we continually find persons doing it. We desire to acquit Mr. Cosgrave entirely of any desire or intention to break rainfall rules; we are certain from the tone of his letter that he has never heard of the objections to such a practice, and to him and to those who like him have not considered the subject, nothing could be more natural than to write such a letter as the above. Indeed, they might well express astonishment that the information which they seek was not reprinted in every issue of *British Rainfall*. Some day, perhaps, we may be compelled to publish as beacons an account of all the home-made gauges which we have tested, but we have no wish to do so. Meanwhile we may briefly sum up our objections. I. Few amateurs have absolute standards of length, hence they cannot be certain of the diameter of the funnels they may employ to 0·001 in. which is expedient, or even to 0·01 in. which is necessary. II. Fewer persons still have accurate measures of capacity; so-called "ounce glasses" often vary considerably, and amateur dividing is rarely either regular or legible. III. It is most desirable to have uniformity in every branch of Meteorology, and this is simply hopeless if people are to make and fit up their own instruments.

We have no wish to withhold information from any one, and we, therefore, append that which is asked for, but we hope that before publishing any results from gauges constructed in accordance with this table, the makers will carefully consider the above objections.

Diameter.	Area.	One inch of water over this area is—		
in.	in.	Grains.	Troy Ounces.	Avoirdupois Ounces.
6 ...	28·274 ...	7140 ...	14·875 ...	16·320
9 ...	63·617 ...	16065 ...	33·469 ...	36·720
12 ...	113·097 ...	28560 ...	59·500 ...	65·280

ED.]

JANUARY, 1875.

Div.		STATIONS. [The Roman numerals denote the division of the Annual Tables to which each station belongs.]	RAINFALL. Total Fall.	Difference from average 1860–5	Greatest Fall in 24 hours. Dpth	Date.	Days on which ·01 or more fell.	TEMPERATURE. Max. Deg.	Date.	Min. Deg.	Date.	No. of Nights below 32°. In shade	On grass
			inches	inches.	in.								
I.	ENGLAND.	Camden Town	3·22	+ 1·27	·42	1	26	53·8	18	20·7	1	4	7
II.		Maidstone (Linton Park)	3·62	+ 1·56	·63	22	19	56·0	18	12·0	1	4	...
,,		Selborne (The Wakes)	5·10	+ 1·83	·60	1	22	51·0	23*	6·0	1	5	5
III.		Hitchen	2·15	+ ·01	·36	1	21	51·0	18†	22·0	1	5	...
,,		Banbury	2·69	+ ·60	·50	1	21	53·0	18†	15·0	1	6	...
IV.		Bury St. Edmunds (Culford)	2·34	+ ·47	·34	1	15	54·0	19	28·0	21§	6	9
V.		Bridport	4·81	+ 1·62	1·10	1	27	55·0	28	29·0	22	3	..
,,		Barnstaple	5·53	+ 2·01	·73	23	26	57·0	16	27·5	1	...	...
,,		Bodmin	10·52	+ 5·33	1·45	1	30	55·0	14	32·0	22	1	1
VI.		Cirencester	5·30	+ 2·30	·74	24	23	...	...	...	...	...	...
,,		Shifnal (Haughton Hall)	2·46	+ ·56	·46	29	24	54·0	19	20·0	1	5	10
,,		Tenbury (Orleton)	3·16	+ ·63	·53	1	23	55·2	18	17·8	1	5	7
VII.		Leicester (Belmont Villas)	2·97	...	·51	1	21	55·0	14	9·8	1	3	...
,,		Boston	2·03	+ ·32	·38	23	16	55·0	19	14·0	1	4	...
,,		Grimsby (Killingholme)	1·75	...	·28	1	19	52·5	19	6·5	1	4	...
,,		Derby	3·01	+ 1·22	·51	1	22	56·0	31	12·0	1	4	...
VIII.		Manchester	3·57	+ 1·05	·63	1	21	55·0	14	26·5	22	4	10
IX.		York	2·29	+ ·71	...	...	...	...	...	...	...	...	...
,,		Skipton (Arncliffe)	10·78	+ 5·14	1·68	18	30	49·0	18	18·0	1	...	...
X.		North Shields	2·33	+ ·22	·30	3	28	53·8	9	11·2	1	5	12
,,		Borrowdale (Seathwaite)	22·88	+ 6·52	2·28	17	30	...	...	...	...	...	...
XI.	WALES.	Cardiff (Ely)	...	...	...	..	...	...	...	...	...	...	...
,,		Haverfordwest	9·70	+ 4·65	1·40	1	30	53·2	19	33·5	21	...	...
,,		Rhayader (Cefnfaes)	...	...	...	...	...	...	...	...	...	...	...
,,		Llandudno	3·03	+ ·49	·41	19	21	61·8	19	25·7	1	1	...
XII.	SCOTLAND.	Dumfries (Crichton Asylum)	7·18	...	·86	4	23	52·6	20	15·0	1	9	12
,,		Hawick (Silverbut Hall)	4·09	...	·90	18	27	...	...	...	...	...	...
XIV.		Kilmarnock (Annanhill)	5·06	...	1·00	18	26	53·0	15	21·8	1	8	14
XV.		Castle Toward	8·13	+ 1·84	·85	20	27	55·0	19	...	...	10	...
XVI.		Leven (Nookton)	4·99	+ 2·12	·54	3	22	53·0	19	12·0	1	14	26
,,		Stirling (Deanston)	...	...	...	...	...	...	...	...	...	...	...
,,		Grandtully	...	...	...	...	...	...	...	...	...	...	...
XVII.		Braemar	4·30	+ 1·17	·67	26	21	50·7	19	17·0	1	12	19
,,		Aberdeen	3·15	...	·45	1	25	53·1	31	15·7	1	10	21
XVIII		Loch Broom	4·49	...	·82	15	23	...	...	...	...	...	..
,,		Portree	8·23	— 4·86	1·06	2	26	...	...	...	...	...	...
,,		Inverness (Culloden)	2·63	+ ·35	...	...	29	52·2	14	15·0	1	13	26
XIX.		Helmsdale	4·42	...	·88	18	23	...	...	...	...	...	...
,,		Sandwick	5·02	+ 1·73	1·14	24	27	48·9	27	24·8	1	7	12
XX.	IRELAND.	Caherciveen Darrynane Abbey	7·36	...	·65	28	26	...	...	...	...	...	...
,,		Cork	7·88	...	·65	12	31	...	...	...	...	...	...
,,		Waterford	7·84	+ 2·98	1·00	14	29	57·0	17	30·0	22	1	...
,,		Killaloe	11·26	+ 6·40	·83	4	30	57·0	28	29·0	6	2	...
XXI.		Portarlington	4·45	+ ·44	·48	18	30	55·0	17	28·0	1	3	...
,,		Monkstown, Dublin	3·60	+ ·21	·36	8	26	...	...	...	...	...	...
XXII.		Galway	5·52	...	·64	2	27	56·0	13‡	31·0	22	2	...
,,		Ballyshannon	4·47	...	·41	1	28	...	...	...	...	...	...
XXIII		Waringstown	4·32	...	·49	4	25	54·0	17	27·0	21	5	12
,,		Edenfel (Omagh)	4·02	...	·44	23	28	52·0	19	26·0	21	8	...

* And 29. † 19. ‡ 15. § 25.

+Shows that the fall was above the average; —that it was below it.

METEOROLOGICAL NOTES ON JANUARY.

ABBREVIATIONS.—Bar. for Barometer; Ther. for Thermometer; Max. for Maximum; Min. for Minimum; T for Thunder; L for Lightning; TS for Thunderstorm; R for Rain; H for Hail; S for Snow.

LINTON.—The year commenced with intense frost, but only for a few hours; it then became very mild, and continued so to the end of the month; the ther. falling eight times below 38°, with frosts on 1st, 2nd, 22nd, and 31st. Winds mostly S. and S.W.; very high on the 24th. The R more frequent than heavy; no S; bar. very high on 31st. Between the 25th and 26th, it rose upwards of an inch in 24 hours. On the whole the month has been a remarkably mild one.

SELBORNE.—On 2nd the first thaw in shade for three weeks; 20th, violent wind from W. by S., continuing all night; S on 21st at 4 p.m.; 22nd, bar. rose 0·70 in twelve hours; much wind on 24th and 25th, with heavy H at 9 a.m. and 4 p.m. on 24th, and again on 25th; fog on 28th, 29th, and 30th, and white frost on 31st. The month exceptionally mild for January; productive of rheumatism. The ground, both in fields and gardens, so wet that it could scarcely be worked.

BANBURY.—High wind on 1st, 6th, 14th, 16th, 19th, and 20th.

CULFORD.—The year commenced with mild weather, which still continues. The highest temp. was 54° on the 19th; the lowest 38° on 21st and 25th. The mean temp. of the month was 41°·7, while that of the preceding month (Dec.) was only 30°·5. No S fell during the month; T was heard on the night of 16th, and high winds prevailed on the three following days, and again on the 23rd and 24th; the wind was westerly on 19 days, and easterly on 12 days.

BRIDPORT.—1st, very high floods produced by the very rapid melting of the S (that fell in December), and the heavy R (1·10) of this day; a little S fell on this day. A very wet and miserable month, and particularly noticeable for the great number (27) of days on which R fell. On the 24th a very severe gale from the W. N.W.

BODMIN.—The rainfall this month (10·52) is the highest ever recorded during the past 26 years, except in November, 1852, when 11·01 in. fell. The mean temp. of the month was 48°·1, being 5°·5 above the average.

SHIFNAL.—The severe weather which had lasted through December, and come to a climax on the last night of the year, relaxed on the 1st of January; the min. ther. rising from 14° to 20°, from which day it never fell below 27° throughout the month, nor below 32°, except on five nights. The average max. of the month was 46°, and the average min. 36°. The R, through falling on 24 days, was slight; the heaviest falls being ·40 on 1st, and ·46 on the 29th. The prevailing winds were S. and S.W.; a heavy storm from thence on the 24th; indicated by withstanding the late severe weather. Christmas roses in flower on the 12th; a sudden fall of the bar. that morning. Symptoms of an early spring not-aconites and snowdrops up on 17th; catkins out on the hazels on 21st; and snowdrops fully open on the 28th. Throstle singing from 14th; stockdove first heard on the 23rd. S on the 22nd.

ORLETON.—The frost was severe on the morning of the 1st and was followed by S and R, and a steady thaw at night, which cleared the S off the ground by the 4th, when the rivers overflowed their banks. The weather afterwards was very cloudy, damp, and warm, with frequent slight falls of R; much fog, and very little clear sky. The mean temp. of the month was about 6°·2 above the average, and much higher than that of any month of January for more than 20 years past. On the 24th the bar. fell to 28·70, and on the 30th stood at 30·40 (uncorrected). Violent winds on the 19th and 24th; distant L on the night of the 24th; lunar halo on 22nd; S 3 to 4 in. deep on the 23rd; much R in the night of the 20th and 21st; brooks high on the 21st.

LEICESTER.—Very mild month; only three nights on which the temp. was below 32°. On the night of the 1st R fell, which froze as it fell, coating every thing with ice. General direction of wind during the month S.W.

BOSTON.—Frost broke up with rapid thaw on the 2nd; the min. temp. rising from 16° to 35°. Mean temp. 4°·2 above the average of previous 11 years. Wind S.W. on 21 days; S.E. on 7 days; N.W. on 2 days; and N.E. on 1 day. Very stormy on 19th; windy, with R, on 23rd and 24th.

GRIMSBY.—Min. temp. on 1st 6°·5 ; magnificent rime. Silver thaw on 2nd. A great number of birds starved to death ; redbreasts singing on 12th, and the thrush on 15th. Aconite in flower on 22nd ; crocuses on the 30th ; and hazel catkins shedding their poller on the same day. On the whole a seasonable month.

MANCHESTER.—R and H on the 1st.

NORTH SHIELDS.—Distant lunar halo on 18th ; lunar halo on 22nd ; followed by S.

SEATHWAITE.—Total fall (22·88) on 30 days, on 10 of which it exceeded 1·00 in., on 5 days it exceeded 1·50 in. ; the max. fall being 2·88 in. on 17th.

WALES.

HAVERFORDWEST.—A month of R, gloom, and mildness. Very stormy, with heavy R the first three days ; the ther. never fell to the freezing, nor did the sun appear during the whole month. A great storm of T, L, H, R, and wind, on 24th ; L forked. Extreme depression of bar, being 28·94 (corrected). 25th, very stormy ; the wet weather continued without intermission to the end of the month ; the 7th being the only day on which R was not recorded. The bar. pressure increased in a remarkable manner from the 26th to the 31st ; at 9 a.m. on 30th 30·60, 9 p.m. 30·68 ; at 9 a.m. on 31st 30·50.

LLANDUDNO.—2nd, all the S gone, except on the distant hills. Snowdrops peeping on 4th ; anemones in flower on 6th. Thrush began to sing on 7th, and ceased on the 19th. Snowdrops and crocii in flower on 23rd ; sycamore in leaf-bud on 22nd ; jargonel pear shewing buds on 24th ; mezereum and primroses in flower in the garden on 26th. S on the hills till the 26th ; no frost except on the 1st. Altogether a mild month, and vegetation too forward.

SCOTLAND.

DUMFRIES.—The rainfall this month is nearly double the average for this district, and was brought chiefly by the E. and S.E. winds. S fell on 1st, 20th, 23rd (heavy), and 26th. Strong wind from S.W. on 4th ; wind from W. and N.W. on 18th ; and gale from S.W. on the following day.

HAWICK.—New year's day was a terrible day for snowdrift and wind ; the train which left Hawick for Edinburgh in the morning, stuck in a snow-wreath at Falahill, and many of the passengers had to pass the night in the carriages. The month has been a wet one, which has kept back both farming and gardening operations ; the turnips have suffered severely from the effects of the frosts in December. Hill white with S 20th to 25th inclusive ; 18th and 19th very wet and stormy.

ANNANHILL.—Mean temp. nearly 10° higher than last month ; lowest night temp. on grass 18°, on 1st. Wind principally S.E., S, or S.W. ; usually light to moderate. Strong S.W. gale on the night of the 2nd ; gales on 15th, 19th, and 20th ; on the night of the 18th–19th, strong S. westerly gale, with heavy R, and great flood ; the river Irvine overflowed its banks, and fields were inundated. Sky generally $\frac{3}{4}$ cloud ; several of the nights very dark and foggy ; rainfall in excess ; L on 28th. Death-rate of month 52 per 1000 per annum ; number of deaths 104, the largest number recorded in any month since the Registration Act has been in force ; principal cause of death scarletina.

CASTLE TOWARD.—The month has been wet, cold, and stormy. On the 1st heavy fall of S, but disappearing very soon. On 3rd a heavy gale, on sea and land, from W. and N.W., uprooting many trees ; gale on 19th ; fall of S on 26th thawing as it fell. On the 28th, at 6.50 p.m., loud T in W., followed by L, lasting only a short time. 13th, snowdrops in flower, and the thrush first heard singing.

BRAEMAR.—11th, dense fog all day ; 18th and 19th, L. A month of changeable weather throughout. Severe colds very prevalent.

ABERDEEN.—1st, a terrible gale ; temp. on grass 12°·5 ; bar. below the average ; R and temp. above it. Winds from S., S.W., and W., more frequent than the average ; mean estimated pressure less. A month of mild but foggy weather, with frequent gales.

LOCHBROOM.—The month has been a wonderful mixture of all sorts of weather; frost, S, and R, battling for the ascendancy, in short it has been a very severe month for such as had anything to do with outside feeding or grazing.

CULLODEN.—Rainfall slightly above the average. Aurora on the 8th and 30th; L 19th and 28th; frequent falls of S and sleet, the fall of S on the night of Dec. 31st and Jan. 1st was so great and so drifted by a high wind S.S.E. and S. to S.W. that most of the railways were blocked.

PORTREE.—A cold stormy month; wet, with high winds. S on the 21st, 22nd, and 24th. Heavy gale from S.W. on 3rd, and from S. on the 16th.

SANDWICK.—This was the wettest January that we have had since 1863. On the 1st there was a strong gale of S.E. wind, with snowdrift, and at night a thaw, which soon cleared away the S and frost of December. On the 23rd there was again a formation of snow-rollers, which seems peculiar to our climate, and again there was the combination of circumstances which I formerly stated to be necessary for their formation, viz., 1st, a foundation of a previous fall of S.; 2nd, a recent fall of feathery snow-flakes, with calm weather, and ther. below 32°; 3rd, a strong breeze afterwards, with a ther. above 32°, so as to cause the S to adhere while the wind rolled it up. In this case the wind did not exceed 30 miles an hour, which seemed insufficient for forming rollers, except where it was accumulated at the corners of houses or walls. At the corner of my house, about forty were formed, some of them licking up the gravel and transporting it to the lawn, thus illustrating, on a small scale, the transporting of boulders by icebergs; the largest on this occasion were 14 in. in length, and 12 in. in diameter, like ladies' white muffs; one that measured 11 in. in length and 11 in. in diameter, weighed only 3½ pounds.

IRELAND.

DARRYNANE.—This month chiefly remarkable for the amount of fog and mist; on nine days fog on the low ground, on thirteen other days on the hills, with haze on low lands; winds chiefly S.W., W., and N.W., but on the 10th in p.m. S.E.; also on 11th a.m.; 22nd p.m.; 30th a.m.; E. on 21st; and a.m. on 22nd. H on 1st, 6th, and 24th. L on 6th, 15th, 19th, and 24th; T on 6th and 24th. Frost on 22nd; S on mountains on 21st. Very mild weather, but very unfavorable for agricultural operations; ground soaked with the constant fine R. Gale and heavy sea on 8th; 20th very stormy, with terrific sea; 24th tremendous squalls.

WATERFORD.—22nd to 24th rapid fall of bar from 30·10 to 28·80. The temp. remarkably equable during the month.

MONKSTOWN.—The most noteworthy characteristics of the month are the unusual number of wet days, while the actual depth is small, and the absence of frost, which occurred only on one night, 21st, and that very slight.

BALLYSHANNON.—The month set in cold and wintry, and was wet throughout. Loud T and vivid L at 9.30 on the night of the 16th, with H. The gale of the 19th was the severest which is remembered here since the year 1839, when the church was blown down; although of only two hours' duration, the recent gale will long be remembered for the extraordinary amount of damage which occurred, many roofs were blown off houses, walls tossed, hayricks blown away, and telegraph wires thrown down.

WARINGSTOWN.—Very wet and stormy, tremendous gale for some hours on night of 19th-20th; several large trees blown down here.

EDENFEL OMAGH.—The month was mild and wet, almost without intermission; there was but little frost or S; but about midnight on the 19th this district was visited by the most terrific gale of this century; between 9 and 11.30 p.m. the bar. fell from 29·10 to 28·30, the full force of the storm fortunately only lasted from 11.45 to 12.30 (0·30 a.m. of 20th), but during that time immense damage was done to trees, buildings and farmsteadings. Having made enquiry of those who remember all the circumstances attending the great storm of 6th January, 1839, I am led to the conclusion that this storm was, for the time I have mentioned, of greater violence, and that this district (upon which its full force seems to have been expended) was saved from a great calamity only by the shortness of its duration.